



## **Voltage-stabilised elastomers with increased relative permittivity and high electrical breakdown strength by means of phase separating binary copolymer blends of silicone elastomers**

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## Electronic Supplementary information

### Voltage-stabilised elastomers with increased relative permittivity and high electrical breakdown strength by means of phase separating binary copolymer blends of silicone elastomers

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#### 1) Calculation of engineering stress and strain

The engineering stress ( $\sigma_E$ ) was calculated from the force ( $F$ ) and the cross-sectional area of the strip ( $A$ ):

$$\sigma_E = \frac{F}{A} = \frac{F}{t \times w} = \frac{\tau \cdot d}{t \cdot w}$$

Equation 1

where  $A$  = film thickness ( $t$ ) · constant width ( $w = 6$  mm) and  $F$  = torque ( $\tau$ ) · drum diameter ( $d = 10.3$  mm).

The engineering strain ( $\epsilon_E$ ) was calculated as a ratio of a stretched strain ( $L - L_0$ ) to an initial strain ( $L_0$ ) as:

$$\epsilon_E = \frac{L - L_0}{L_0}$$

Equation 2

where a final strain after stretching ( $L$ ) was determined from Hencky strain ( $\epsilon_H$ ) as follows:

$$\epsilon_H = \ln \frac{L}{L_0}$$

Equation 3

$$L = L_0 e^{\epsilon_H} = L_0 e^{(r_H \cdot t_s)}$$

Equation 4

where  $\epsilon_H$  is a product of Hencky rate ( $r_H = 1 \times 10^{-3}$  rotation/s) and step time ( $t_s$ ).

By putting equation (4) in (2), the final expression of engineering strain ( $\epsilon_E$ ) was obtained as below:

$$\epsilon_E = e^{\epsilon_H} - 1$$

Equation 5

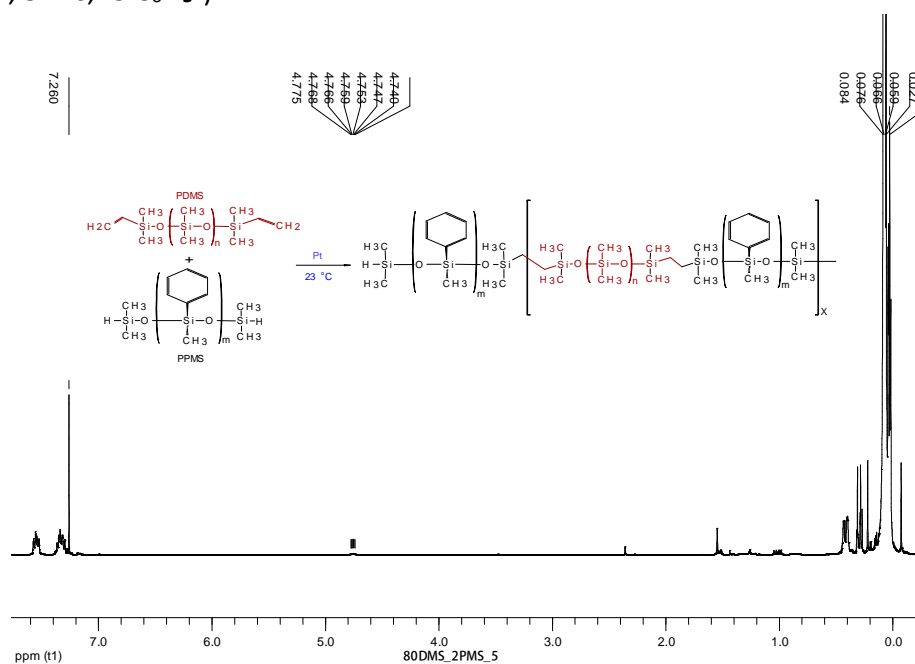
Young's moduli were determined from slopes in the linear regime of stress-strain plots at 5 % strain.

## 2) NMR spectra of synthesised copolymers

The NMR spectra for synthesised PDMS-PPMS and PDMS-PEG copolymers are shown in Figures S1– S5.

a) PDMS-PPMS copolymer (**80DMS\_2PMS**,  $C_{C_6H_6} = 8.4 \cdot 10^{-4} \text{ mol g}^{-1}$ )

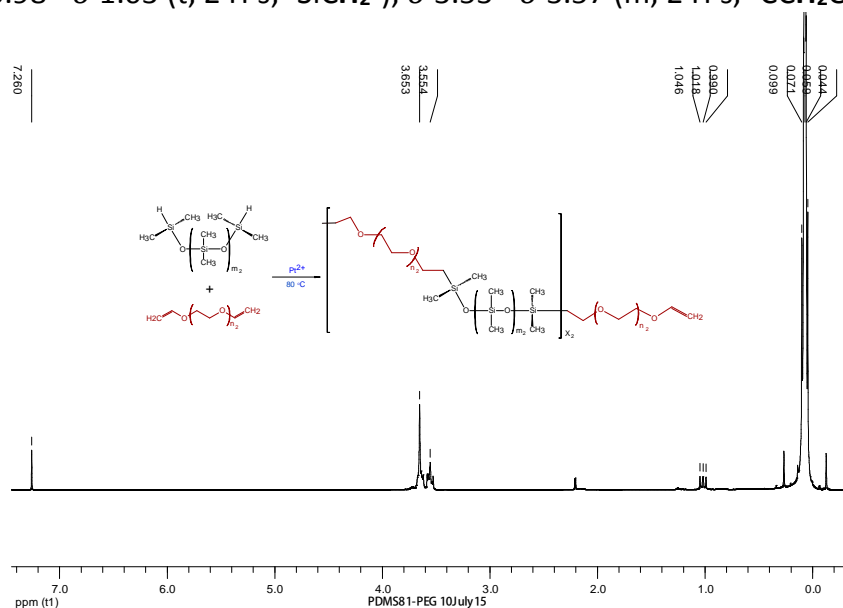
$^1\text{H-NMR}$  ( $\text{CDCl}_3$ , 300 MHz):  $\delta$  -0.02 -  $\delta$  0.6 (m, 6 H's,  $-\text{SiO}(\text{CH}_3)_2-$ ),  $\delta$  4.70 (m, 1 H,  $-\text{SiH}-$ ),  $\delta$  7.10 -  $\delta$  7.60 (m, 5 H's,  $-\text{SiC}_6\text{H}_5-$ ).



**Figure S1** The NMR for 80DMS\_2PMS.

b) PDMS-PEG copolymer (**PDMS81-PEG**)

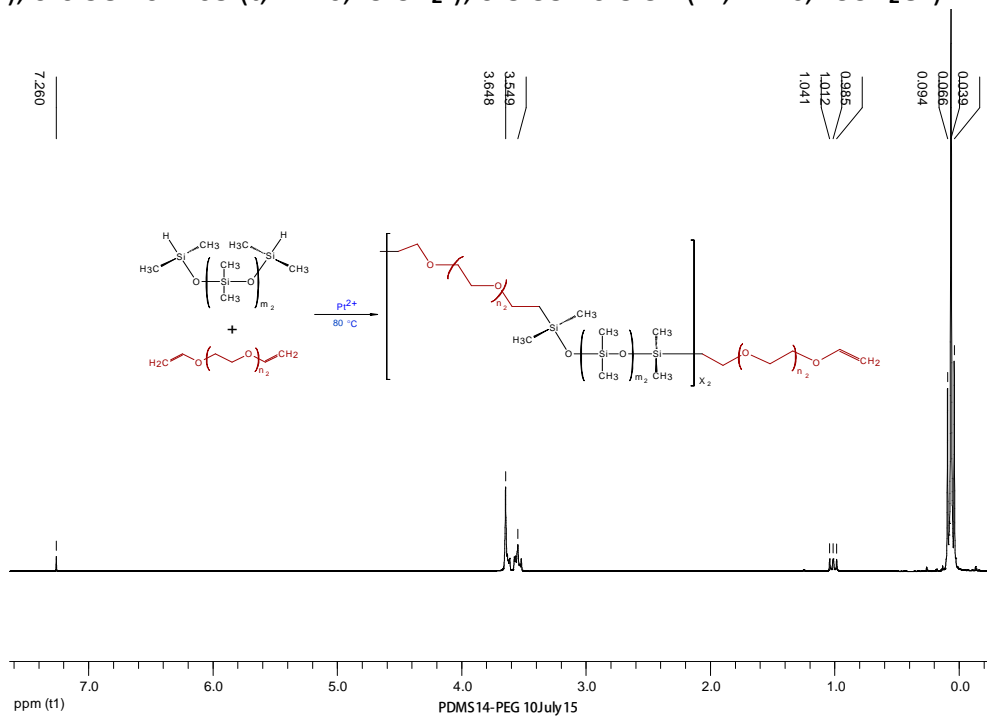
$^1\text{H-NMR}$  ( $\text{CDCl}_3$ , 300 MHz):  $\delta$  0.05 -  $\delta$  0.09 (m, 6 H's,  $-\text{Si}(\text{CH}_3)_2\text{O}-$ ),  $\delta$  3.50 -  $\delta$  3.70 (m, 4 H's,  $-\text{C}_2\text{H}_4\text{O}-$ ),  $\delta$  0.98 -  $\delta$  1.03 (t, 2 H's,  $-\text{SiCH}_2-$ ),  $\delta$  3.53 -  $\delta$  3.57 (m, 2 H's,  $-\text{CCH}_2\text{O}-$ ).



**Figure S2** The NMR for PDMS81-PEG.

c) PDMS-PEG copolymer (**PDMS14-PEG**)

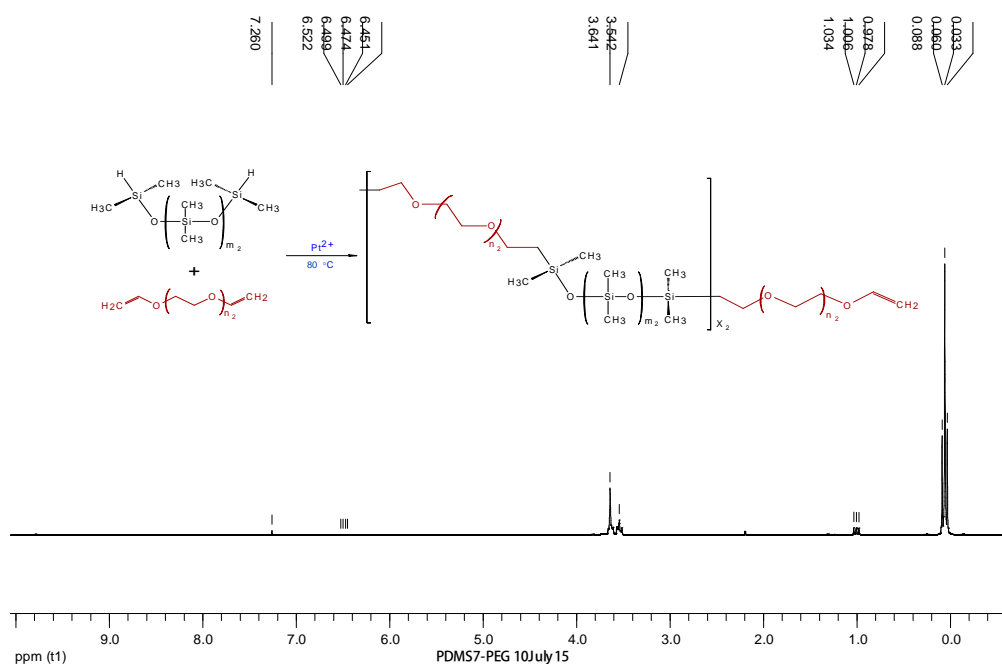
$^1\text{H-NMR}$  ( $\text{CDCl}_3$ , 300 MHz):  $\delta$  0.05 -  $\delta$  0.09 (m, 6 H's,  $-\text{Si}(\text{CH}_3)_2\text{O}-$ ),  $\delta$  3.50 -  $\delta$  3.70 (m, 4 H's,  $-\text{C}_2\text{H}_4\text{O}-$ ),  $\delta$  0.98 -  $\delta$  1.03 (t, 2 H's,  $-\text{SiCH}_2-$ ),  $\delta$  3.53 -  $\delta$  3.57 (m, 2 H's,  $-\text{CCH}_2\text{O}-$ ).



**Figure S3** The NMR for PDMS14-PEG.

d) PDMS-PEG copolymer (**PDMS7-PEG**)

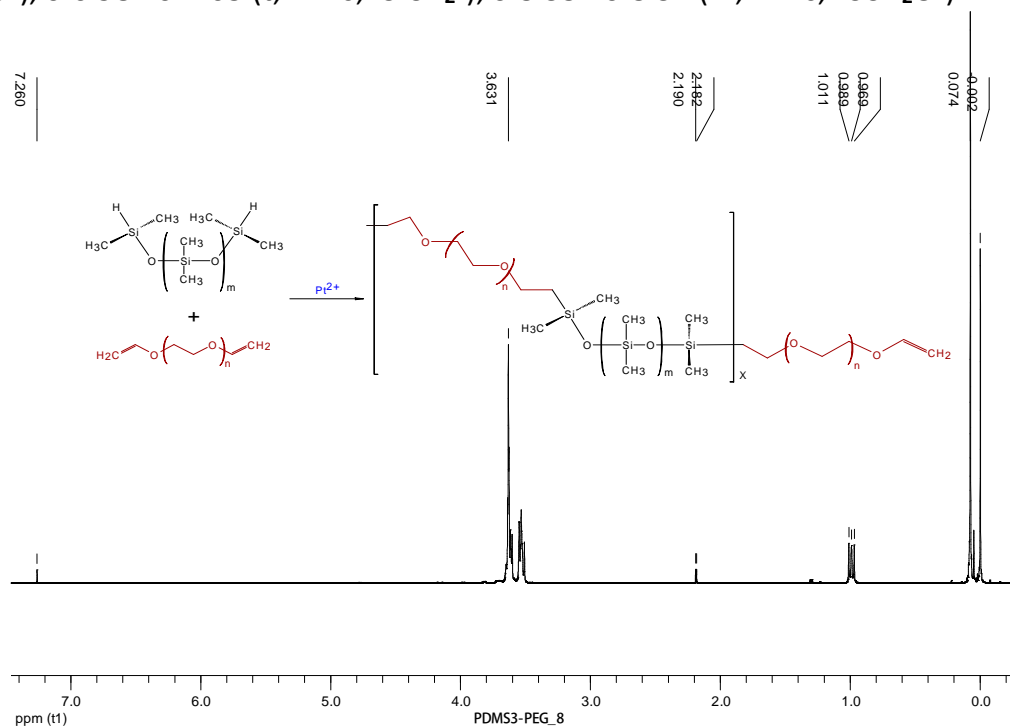
$^1\text{H-NMR}$  ( $\text{CDCl}_3$ , 300 MHz):  $\delta$  0.05 -  $\delta$  0.09 (m, 6 H's,  $-\text{Si}(\text{CH}_3)_2\text{O}-$ ),  $\delta$  3.50 -  $\delta$  3.70 (m, 4 H's,  $-\text{C}_2\text{H}_4\text{O}-$ ),  $\delta$  0.98 -  $\delta$  1.03 (t, 2 H's,  $-\text{SiCH}_2-$ ),  $\delta$  3.53 -  $\delta$  3.57 (m, 2 H's,  $-\text{CCH}_2\text{O}-$ ).



**Figure S4** The NMR for PDMS7-PEG.

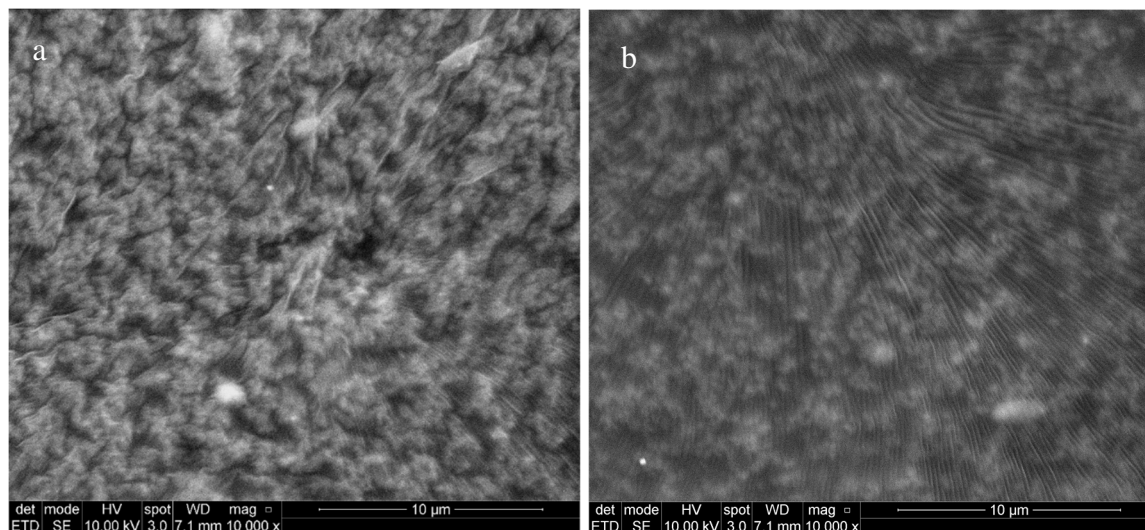
e) PDMS-PEG copolymer (**PDMS3-PEG**)

$^1\text{H-NMR}$  ( $\text{CDCl}_3$ , 300 MHz):  $\delta$  0.05 -  $\delta$  0.09 (m, 6 H's,  $-\text{Si}(\text{CH}_3)_2\text{O}-$ ),  $\delta$  3.50 -  $\delta$  3.70 (m, 4 H's,  $-\text{C}_2\text{H}_4\text{O}-$ ),  $\delta$  0.98 -  $\delta$  1.03 (t, 2 H's,  $-\text{SiCH}_2-$ ),  $\delta$  3.53 -  $\delta$  3.57 (m, 2 H's,  $-\text{CCH}_2\text{O}-$ ).

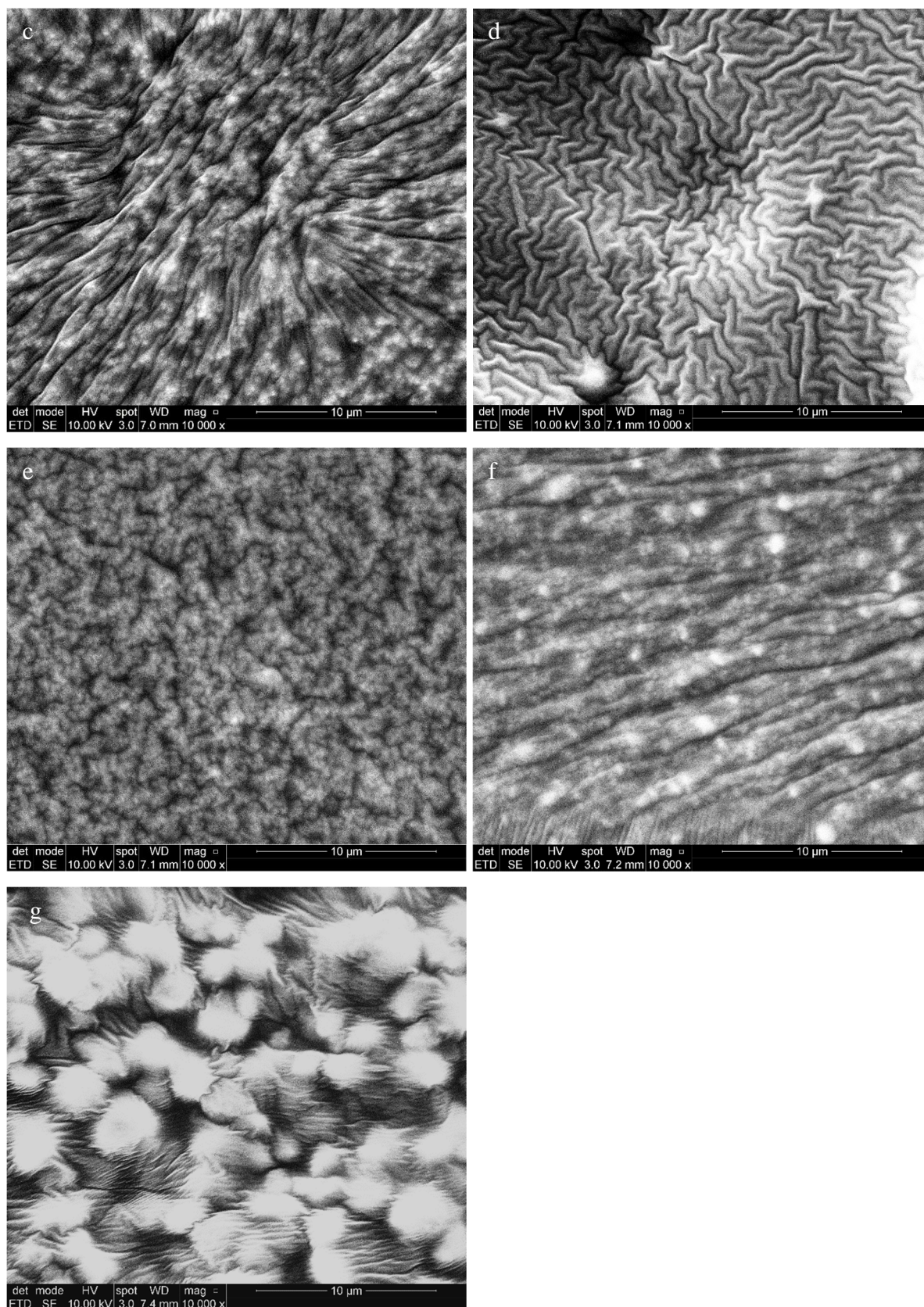


**Figure S5** The NMR for PDMS3-PEG.

**3) SEM images**







**Figure S6** SEM images cross-linked BCBs with: **a)** 10 phr PDMS81-PEG, **b)** 20 phr PDMS81-PEG, **c)** 10 phr PDMS14-PEG, **d)** 20 phr PDMS14-PEG, **e)** 10 phr PDMS7-PEG, **f)** 10 phr PDMS3-PEG, and **g)** 20 phr PDMS3-PEG.